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Direct spectroscopic observation of the atomic-scale mechanisms of clustering and homogenization of rare-earth dopant ions in vitreous silica

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Abstract

Structural aspects of clustering of rare earth ions in oxide glasses have been studied for the last several years in relation to their applications in photonics. However, the mechanism of homogenization of the spatial distribution of rare earth ions by codoping, typically with Al or P, is still not well understood. In this work we report direct experimental determination of the homogenization mechanism of Yb3+ ion clusters in silica glasses doped with 0.1 wt. % Yb2 O3 and codoped with Al or P, using two-dimensional HYSCORE-EPR spectroscopy. The results lead us to conclude that Yb creates its coordination environment via formation of Yb-O-Si and Yb---Yb bonds in a Yb-doped silica glass and even the light codoping with Al starts replacing these bonds with Yb-O-Al linkages. Heavy codoping with P replaces all Yb-O-Si Yb linkages with Yb-O-P linkages. The formation of a next-nearest neighbor shell of Al or P creates suitable structural pockets, which ultimately leads to homogenization. © 2006 The American Physical Society.

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